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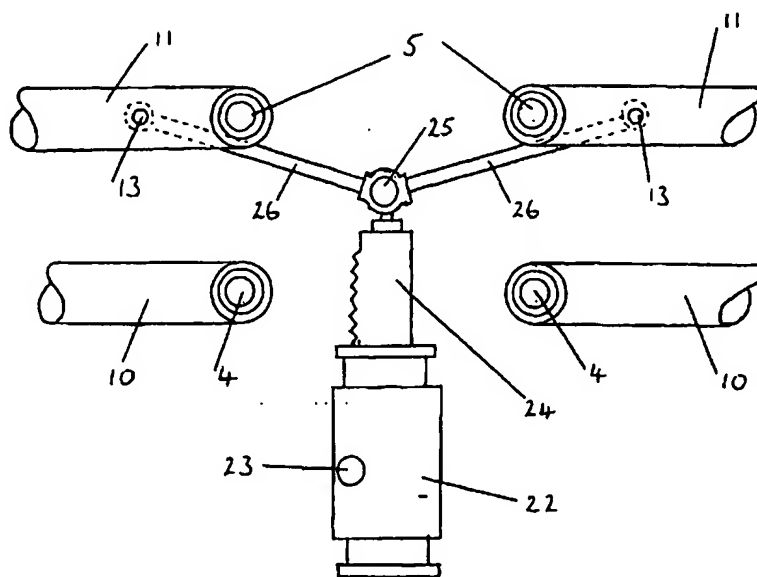
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Declaration under Rule 4.17:

— as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GI, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA.

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(54) Title: MECHANISM FOR CONTROLLING WHEEL LOCATION AND STEERING IN A VARIABLE TRACK VEHICLE



(57) Abstract: An assembly, which can be incorporated within a variable track vehicle, enables the location of the road wheels concerned to be altered from retracted to extended configuration and also enables such wheels to be steered at all times, including during retraction or extension. The assembly involves pairs (disposed symmetrically about the vehicle centre line) of rods, including rods 10 and 11, forming upper and lower parallelograms. Suspension and steering components are connected to the outer members of such parallelograms. Wheel location is effected by movement of a ram (24) acting through other components on rods 11. Steering is effected by a pair of push-pull cables, fixed to the chassis and acting on the wheels hubs, arranged such that the steering angle is substantially independent of the vehicle track dimension.

WO 02/14086 A1



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Title: MECHANISM FOR CONTROLLING WHEEL LOCATION AND STEERING IN
A VARIABLE TRACK VEHICLE

Description of Invention

This invention relates to motor vehicles.

5 The invention has been devised with the object in view of providing a robust mechanism for steering the front wheels of a motor vehicle in conjunction with a mechanism for effecting longitudinal and lateral movement of such wheels. Such mechanisms can enable construction of an exceptionally compact vehicle for the transport of a small number of persons, which is able to occupy a minimum amount of road space in a
10 retracted configuration but which nevertheless has satisfactory stability when operated at higher speeds in an extended configuration. In order to realise the full benefits of these alternative configurations, it is desirable that the transition from one to the other may be made whilst the vehicle is in motion, including motion involving changes in direction.

Possible mechanisms to achieve these benefits in a passenger vehicle
15 intended for road use are described by Gee in GB 2317862. An essential feature is a parallelogram linkage, for each side of the vehicle, that ensures the wheel supports remain parallel to each other while they are being moved from the retracted configuration to the extended configuration or vice versa. In Gee's design, steering is effected by a system of intermeshing gears and chains and sprockets. Pivots for the latter are at two of the vertices
20 of the relevant parallelogram, thereby ensuring that the steered wheels remain parallel to each other irrespective of the extent to which the wheels are retracted or extended. Gee's description does, however, envisage alternative arrangements and states that the mechanism may comprise gears, sprockets and chains, further pivotally connected elements, or some combination of these.

It is considered that the mechanism as described by Gee would have certain practical disadvantages, probably including excessive play or backlash between the elements and difficulties in making the elements sufficiently rigid without excessive weight. This invention is considered to overcome such disadvantages.

With these desiderata in view, according to one aspect of the present invention, I provide an assembly for use in a motor vehicle comprising:

a chassis structure (but not necessarily a separate chassis frame) or part thereof on to which the elements specified hereafter are attached, which may be integral with the body structure of the vehicle; upper and lower parallelogram linkages of rods and pivots on each side of the vehicle, and rigid links that constrain the upper and lower linkages to move together; suspension which may (but does not necessarily) include wishbones pivoting on the outer rods of the parallelograms, coil springs and dampers; king pins, wheel hubs, track rod ends and brakes (some or all of which may be integral with each other); road wheels and tyres; a ram for activating displacement of the parallelogram linkages, with an electric motor or alternative means of power assistance, through further rods attached (on each side) to one of the displaceable elements of the relevant parallelogram; a steering wheel and column; a rack and pinion or other means whereby movement of the steering wheel is transmitted to the components next described; and a pair (one each side) of inner and outer cables attached by suitable unions to both the steering rack (or equivalent component) and track rod ends,

said assembly providing user actuatable means for enabling lateral and lengthwise displacement of a pair of road wheels, in co-ordination with each other, with respect to the chassis structure,

said assembly providing means for steering one lateral pair of road wheels in co-ordination with one another and in co-ordination with the lengthwise and lateral movement irrespective of the extent of lateral and lengthwise displacement and including means for steering such pair of road wheels while lateral and lengthwise displacement is being effected, the mechanism being such that the steering ratio is substantially independent of the lengthwise and lateral displacement of the wheels.

Preferably the assembly relates to the front wheels of a four-wheeled vehicle, unless the vehicle is intended exclusively for low-speed use, as with a fork-lift truck or dump truck, in which case the assembly may relate to the rear wheels.

Preferably the road wheels within the assembly are not driven, unless by
5 electric or hydraulic means which would avoid the complexities of a mechanical drive operating through large and variable angles.

Preferably, a speed-sensitive mechanism for locking the parallelogram linkages in the extended position, either directly or indirectly by locking the ram, so that the linkages cannot be retracted inadvertently (whether by the driver or by unequal cornering or
10 braking forces on the two wheels concerned) while the vehicle is travelling a speed above that at which retraction would be safe.

Preferably the elements of the assembly concerned with steering are arranged to ensure the correct Ackermann angle when the wheels are in the extended configuration. Alternatively, a mechanism could be incorporated whereby the track rod ends could be
15 moved through a small range, by means of additional cables or hydraulic actuation, such that the Ackermann angle varies according to the displacement of the road wheels, thereby providing a correct, or nearly correct, angle irrespective of the lateral and lengthwise displacement of the road wheels.

It is to be understood that when I refer to the assembly comprising elements
20 in parallelogram configuration, in practice the arrangement may differ slightly from a true parallelogram. In conjunction with the degree of compliance built into the various pivots, this could allow the designer to provide variable resistance to the displacement of the wheels, for example increasing as the limits are approached to avoid a jerk when the limit is reached.

Control of lengthwise and lateral movement of the relevant elements of the assembly may be effected by various means such as have already been suggested by Gee.

The invention will now be described by way of example with reference to the accompanying drawings, of which:-

5 Figure 1 is a diagrammatic plan view showing the main elements of the assembly and arrangement of movable elements according to the present invention, in the "extended" configuration;

Figure 2 is a view as Figure 1, in the "retracted" configuration;

Figure 3 is a diagrammatic front view of the same elements of the assembly
10 as are shown in Figures 1 and 2, in the "extended" configuration;

Figure 4 is a diagrammatic front view of the same elements of the assembly as are shown in Figures 1 and 2, in the "retracted" configuration;

Figure 5 is a diagrammatic side view of the same elements of the vehicle as are shown in Figures 1 and 2, in the "extended" configuration;

15 Figure 6 is a diagrammatic side view of the same elements of the vehicle as are shown in Figures 1 and 2, in the "retracted" configuration;

Figure 7 is a plan view of the ram and associated elements in the "extended" configuration;

Figure 8 is a plan view of the ram and associated elements in the "retracted"
20 configuration;

Figure 9 is a plan view of the outer part of the steering mechanism;

Figure 10 is a plan view of the central part of one side of the steering mechanism.

Note that the following components have been omitted for clarity: upper and lower wishbones, hub assemblies including brakes, springs, dampers, elements of the steering mechanism and any necessary brackets, adjusters and brake hoses. Furthermore, neither the ram mechanism nor the steering mechanism are shown in Figures 1 to 6.

A variation of the invention concerns an alternative mechanism for effecting lengthwise and lateral displacement of the road wheels. In this variation, all the elements shown in Figures 1 to 6 inclusive and Figures 9 and 10 are unchanged, except for the deletion of pivots 13. The variation involves substituting two hydraulic rams as shown diagrammatically in Figures 11 and 12 instead of the single ram arrangement shown in Figures 7 and 8.

Referring firstly to Figures 1 to 6 of the drawings, these show diagrammatically a possible arrangement of components constituting the assembly according to the invention. Some components are shown as straight lines oriented and connected to one another as described hereafter, but it is to be appreciated that in a real vehicle such components will be constructed and arranged generally in accordance with current or future automotive practice. The assembly shown incorporates lengthwise and lateral movement and the associated steering mechanism as for the front wheels of a vehicle according to the invention. If, instead or additionally, the rear wheels are also required to move laterally and lengthwise, a mirror image of components 1 to 17, about an axis at right angles to the centre line of the vehicle concerned, would be linked to the rear wheels: it would be connected to a ram in the same way as shown in Figures 7 and 8 and could be arranged to be actuated simultaneously with, or independently of, ram 24. For use with rear wheels, a steering mechanism as in Figures 9 and 10 could be incorporated or omitted, as desired. The words "vertical" and "horizontal", as used in the following description, are to be understood to include such approximations to these orientations as may be required by the designer or as may occur when the vehicle is in motion .

The assembly is attached at several points to chassis members 1, 2, 3, 17 and 18. In practice, as above referred to in accordance with current or future automotive practice, some or all of these chassis members would probably be constructed as one- (or more) piece metal pressings or fabrications, or moulded components of fibre-reinforced plastics, carbon fibre or other suitable material, and possibly integral with the vehicle body. The assembly is located by vertical pivots 4 and 5 on or equidistant from the centre-line of an upper chassis member 1 of the vehicle concerned. Pairs of upper rods 10 and 11, and lower rods 15 and 20, are fitted with bearings allowing them to move around pivots 4 and 5. Pivots 4 and 5 are secured in vertical positions on to upper chassis member 1 and lower chassis member 3. The outer ends of rods 10 and 11 are fitted with bearings on to vertical pivots 6 and 7 and the outer ends of rods 15 and 20 are fitted with bearings which also allow them to move around pivots 6 and 7. Upper rods 12 and lower rods 14 are attached by further bearings on to pivots 6 and 7. Points 4, 5, 7 and 6 form a parallelogram. An upper suspension wishbone (not shown) pivots on horizontal pivots 8 and 9 which are located on rods 12. A lower suspension wishbone (not shown) pivots on horizontal pivots 21 which are located on rods 14.

The range of lengthwise and lateral movement of one wheel is determined by the angle α through which rods 10, 11, 15 and 20 may move and the length of these rods. Dimension x , which is the distance by which one of the wheels moves laterally from fully extended to fully retracted, is length of rod 10 times cosine α . The distance by which one of the wheels moves longitudinally is length of rod 10 times sine α .

Referring to Figures 7 and 8 of the drawings, these show diagrammatically a possible arrangement of a ram mechanism for actuating lengthwise and lateral displacement of the wheels. The ram is shown as a toothed rod 24 which may be driven by a pinion 23 (connected to an electric motor not shown) within a housing 22. Alternatively the ram 24 could be a piston operated hydraulically within a cylinder 22. A further option would be for the ram 24 to be attached to a peg which is constrained to move by the rotation of a worm drive within 22. The ram 24 is pivotally connected at 25 to a pair of rods 26 which, at their

other ends, are pivotally connected to the rods 11. Thus clockwise rotation of the pinion 23 retracts the ram 24 into the housing 22 and simultaneously pulls the rods 11 rearwards, thereby pulling the road wheels into the retracted position. Conversely, anti-clockwise rotation of the pinion pushes the ram 24 outwards and the rods 11 forwards, thereby pushing
5 the road wheels into the extended position. Friction within the mechanism makes it unlikely that forces on the road wheels (e.g. if one hits a bump) could result in movement of the ram 24. However, as a precaution against this, a locking pin or clamp could be made to engage with ram 24 in one of two positions corresponding to the extended and retracted positions of the wheels. While it is envisaged that movement of the ram 24 (or equivalent device) would
10 be controlled by the vehicle operator, an alternative is for automatic actuation to increase the displacement of the road wheels when the speed of the vehicle concerned rises above a pre-determined level and to reduce the displacement when the speed of the vehicle concerned decreases below a pre-determined level. In the latter case it would be desirable to incorporate means to enable the operator to over-ride the automatic actuation.

15

Referring to Figures 9 and 10 of the drawings, these show diagrammatically a possible arrangement of a rack and cable mechanism for steering the road wheels irrespective of their lengthwise and lateral displacement. An assembly as described below is fitted by bolts 35 into slotted holes (for ease of adjustment) in brackets 34 fixed to the
20 chassis 1 (or 11 or some other chassis member). A pair of slides 27 is rigidly attached to the chassis 1 (or some other chassis member). A pair of push-pull cables having outer casings 29 and inner elements 28 is constrained so that the outer casings 29 may slide within the slides 27. The outer cables 29 are fixed to outer cable unions 30 and the inner cables 28 are fitted to inner slides 31. Ball joints 32 are fitted to the outer ends of the inner part of slides
25 31. The other side of ball joints 32 are fixed to the inner end of track rods 33. The outer ends of track rods 28 are fitted to the wheel hubs (not shown). The outer cables 29 are attached to the rack 37. The inner cables 28 are fixed relative to the chassis. The slotted bolts 35 prevent the rack from twisting. A steering wheel (which need not be circular) and column (not shown) operate a pinion 36 which engages on rack 37. Thus movement of the steering
30 wheel is transmitted via the column, pinion 36, rack 37, cables 28 and 29 and track rods 33 to the wheel hubs. By suitable choice of attachment points of the rack 37 and pinion 36, in

relation to pivots 4 and 5, as determined by the distances from the outer ends of track rods 33 in relation to the king pins in the wheel hubs, the geometry is arranged to ensure that a given angle of steering input results in the same angle of steering at the road wheels (subject to variations due to Ackermann angle) irrespective of the displacement of the wheels.

5 Possible alternatives to rack 37 and pinion 36 are a recirculating ball, worm and peg or other means of converting angular to linear movement: whatever mechanism is used it may be provided with a power-assisted mechanism actuated by rotation of the steering wheel.

Referring to Figures 11 and 12 of the drawings, these show diagrammatically a plan view of an alternative arrangement to that in Figures 7 and 8 respectively. The
10 following elements shown in Figures 7 and 8 are deleted: ram housing 22, pinion 23, toothed rod 24, pivot 25, rods 26 and pivots 13. A pair of hydraulic rams 40 are pivotally attached at one end at pivots 39 to a transverse chassis member 38. The other ends of the hydraulic rams 40 are pivotally attached at pivots 41 to rods 10. Alternatively these ends of the hydraulic rams 40 may be pivotally attached to one of the other elements that is
15 constrained to move with rods 10, such as rods 20 or vertical pivots 6 or to an additional vertical element fixed between rods 10 and 20. The pair of hydraulic rams 40 are operated synchronously by means of a single hydraulic pump (not shown) and hydraulic pipes (not shown) from the pump to the rams 40.

The features disclosed in the foregoing description, or the following claims,
20 or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS

1. An assembly incorporated within a motor vehicle comprising:
an arrangement of rods and pivots and attachments for the purpose of
variably locating a pair of displaceable and steerable ground-engaging wheels
5 (hereinafter referred to as road wheels), an electric motor, pinion and ram
arrangement with further rods and pivots for the purpose of changing the lengthwise
and lateral displacement of the road wheels, a steering wheel, column, rack and
pinion steering gear and an arrangement of cables, unions and sliders for the purpose
of steering the road wheels;
- 10 said assembly providing a user actuatable motor, pinion and ram for enabling
lengthwise and lateral displacement of the road wheels, in co-ordination with each
other, with respect to the chassis structure on or in which the assembly is mounted,
including means whereby the lengthwise and lateral displacement of the road wheels
is controlled by elements pivotally connected together in parallelogram
15 configuration (as viewed in plan), each wheel provided with lengthwise and lateral
movement being connected, with appropriate suspension and brakes, to the outer
longitudinal element of the appropriate parallelogram, and means for locking the
ram, and hence the displaceable road wheels, in at least two displacement
configurations; the arrangement being such that the assembly of elements connected
20 together in parallelogram configuration is capable of assuming a position (herein
called the retracted position) in which the lateral width of each parallelogram is at its
minimum, a position (herein called the extended position) in which the lateral width
of each parallelogram is at its maximum, and any geometrically possible position
intermediate between the retracted and extended positions, or positions beyond the
25 extended position in which the lengthwise displacement from the retracted position
is further increased but the lateral displacement from the extended position is
reduced;

said assembly providing means for steering the pair of road wheels in
co-ordination with each other and in co-ordination with the lengthwise and lateral

- displacement of the road wheels, irrespective of the extent of lengthwise and lateral displacement and including means for steering the pair of road wheels while lengthwise and lateral displacement is being effected, the mechanism being such that the steering ratio is substantially independent of the lengthwise and lateral displacement of the wheels.
- 5
2. An assembly as claimed in Claim 1, wherein the lengthwise and lateral displacement is actuated by a hydraulic ram instead of a rack and pinion.
3. An assembly as claimed in Claim 1, wherein the lengthwise and lateral displacement is actuated by a worm drive and peg with attached rod instead of a rack and pinion.
- 10 4. An assembly as claimed in Claim 1, Claim 2 or Claim 3, wherein means are provided for preventing actuation of the displacement mechanism while the vehicle concerned is travelling at more than a predetermined speed.
5. An assembly as claimed in Claim 1, Claim 2, Claim 3 or Claim 4 wherein means are provided for automatic actuation to increase the displacement of the road wheels
- 15 when the speed of the vehicle concerned rises above a pre-determined level and to reduce the displacement when the speed of the vehicle concerned decreases below a pre-determined level.
6. An assembly as claimed in Claim 5, wherein means are provided to enable the user to over-ride the automatic actuation of the displacement of the road wheels.
- 20 7. An assembly as claimed in any of Claims 1 to 6 in which the steering mechanism incorporates a recirculating ball, worm and peg or other means of converting angular to linear displacement, instead of a rack and pinion.

8. An assembly as claimed in any of Claims 1 to 7 in which the steering mechanism includes a power-assisted mechanism actuated by rotation of the steering wheel.

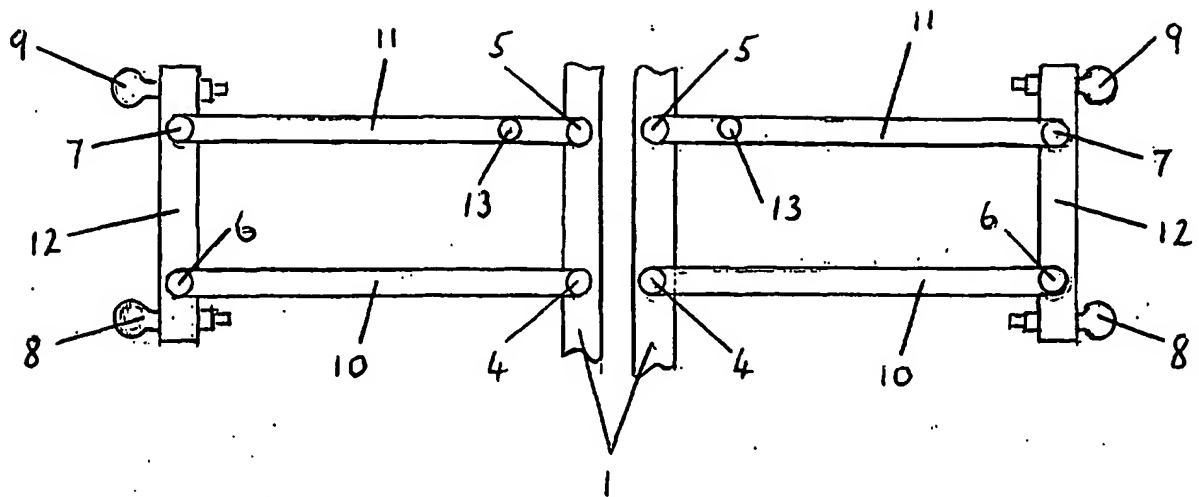


Fig. 1

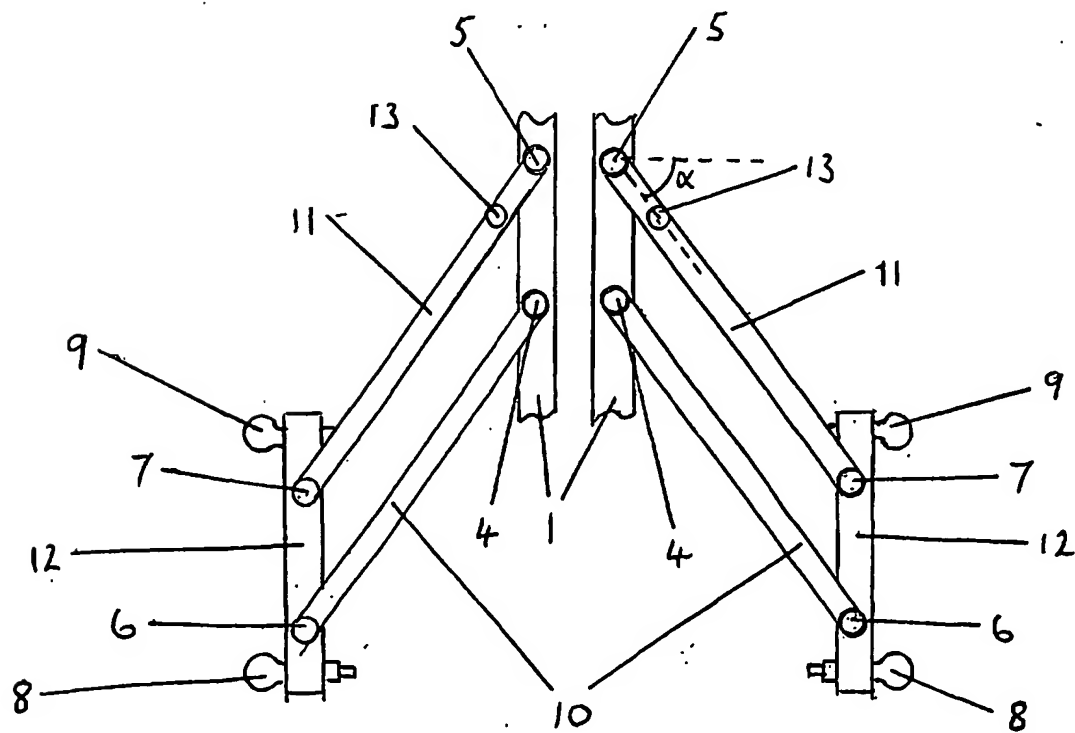


Fig. 2

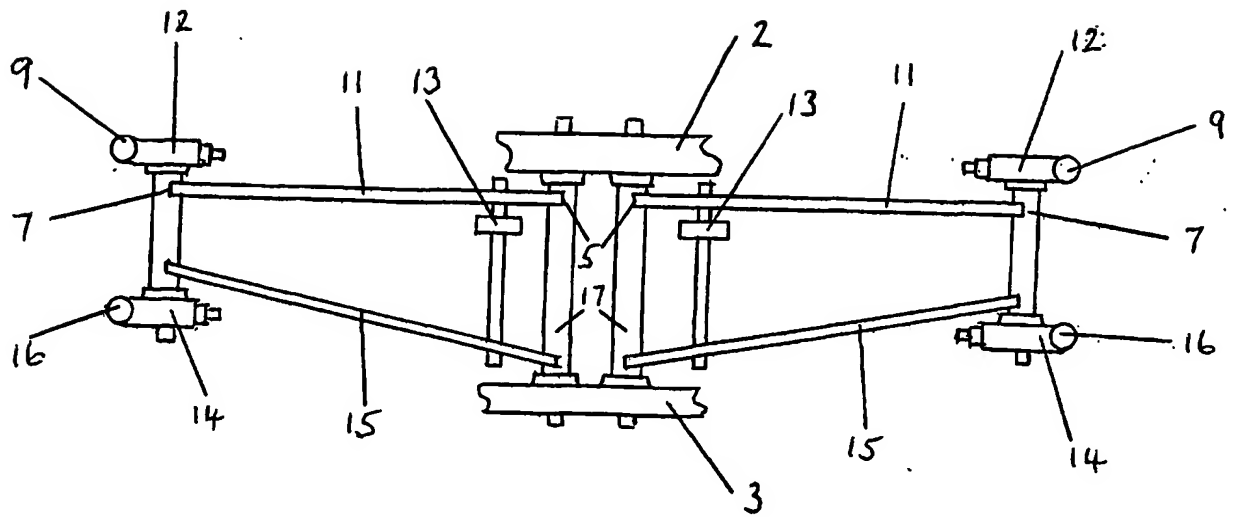


Fig. 3

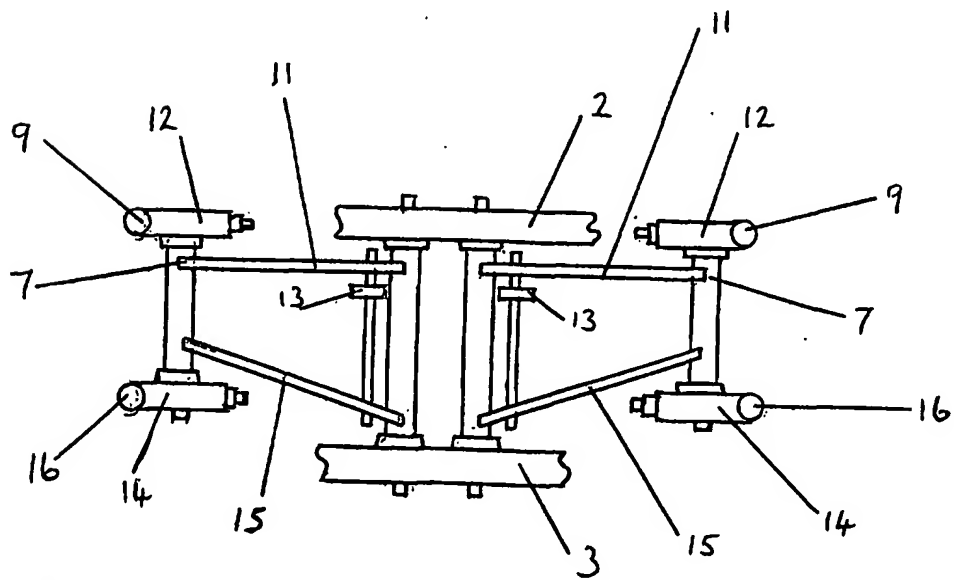


Fig. 4

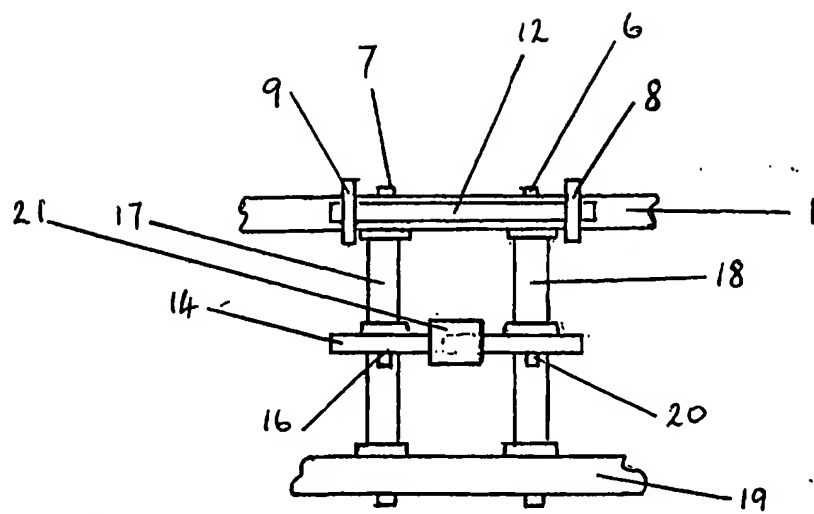


Fig. 5

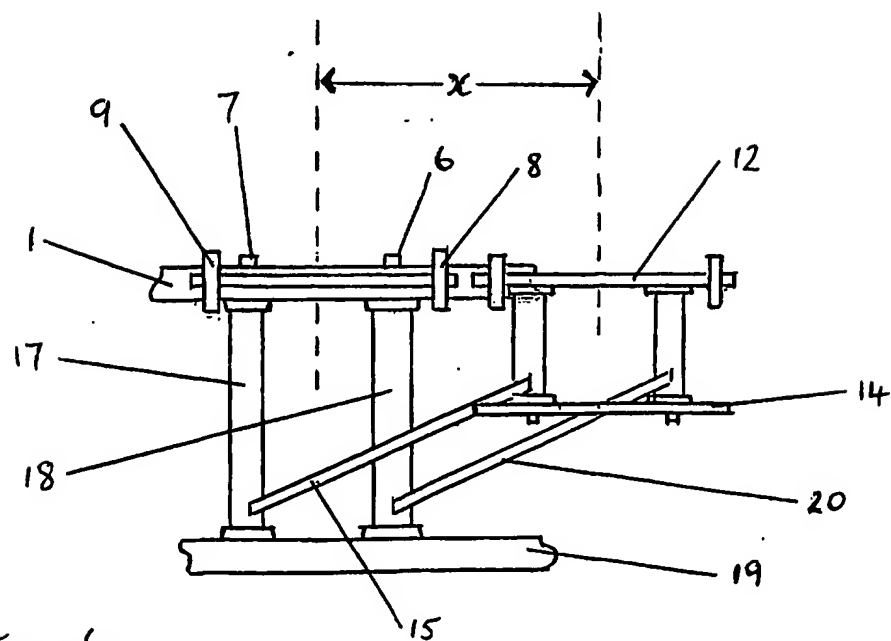
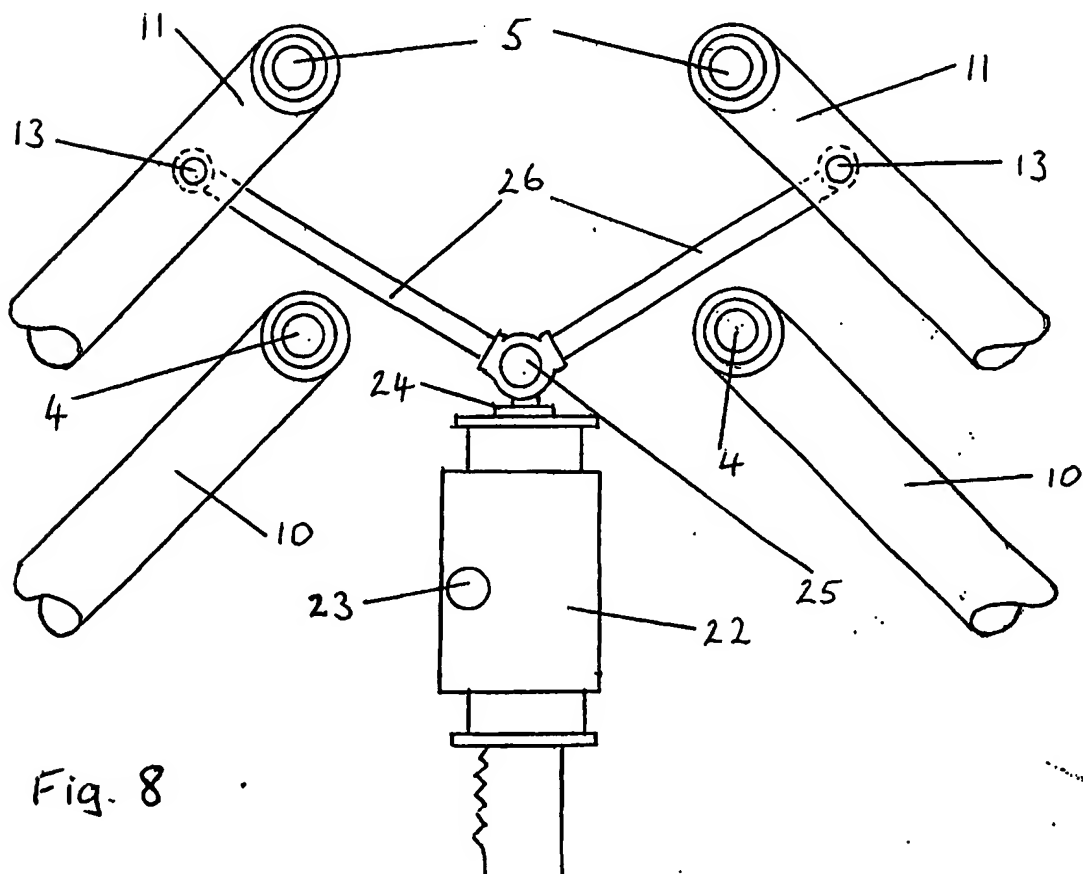
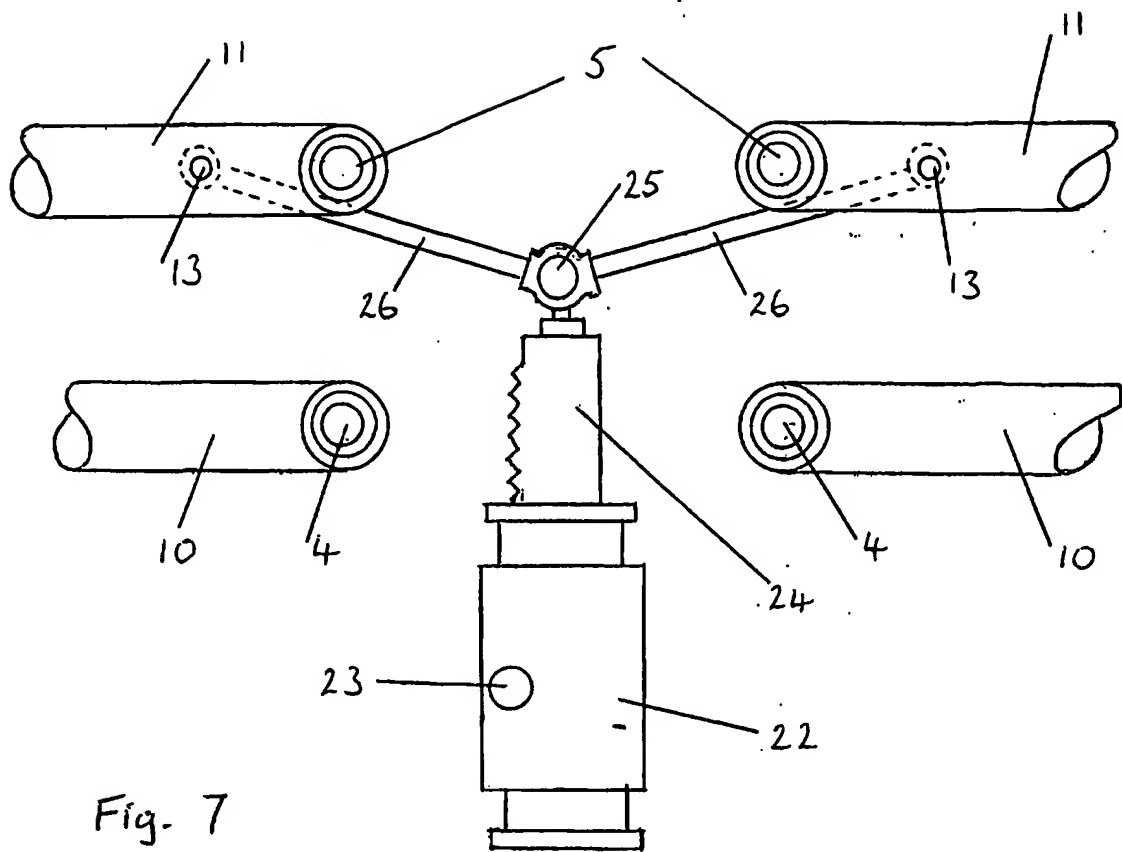
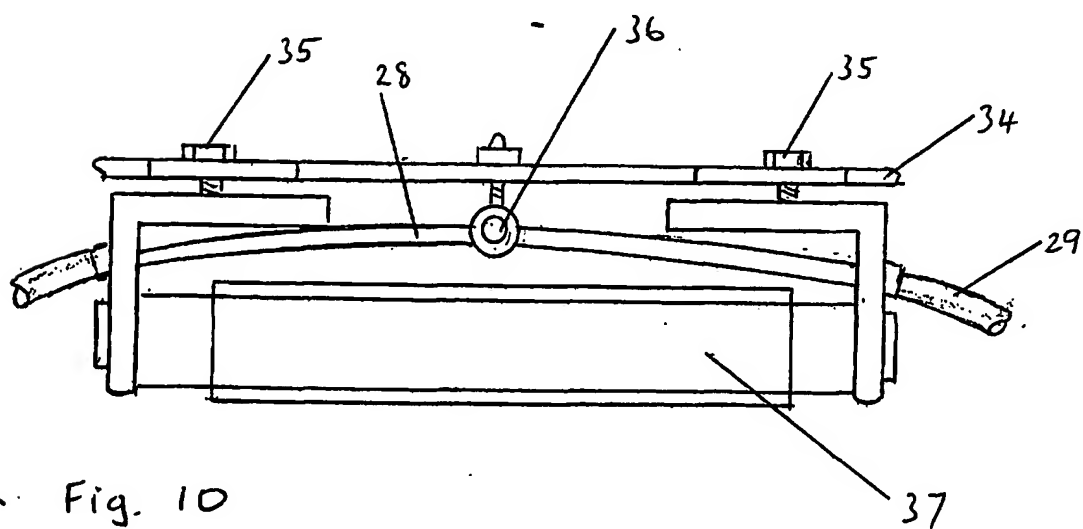
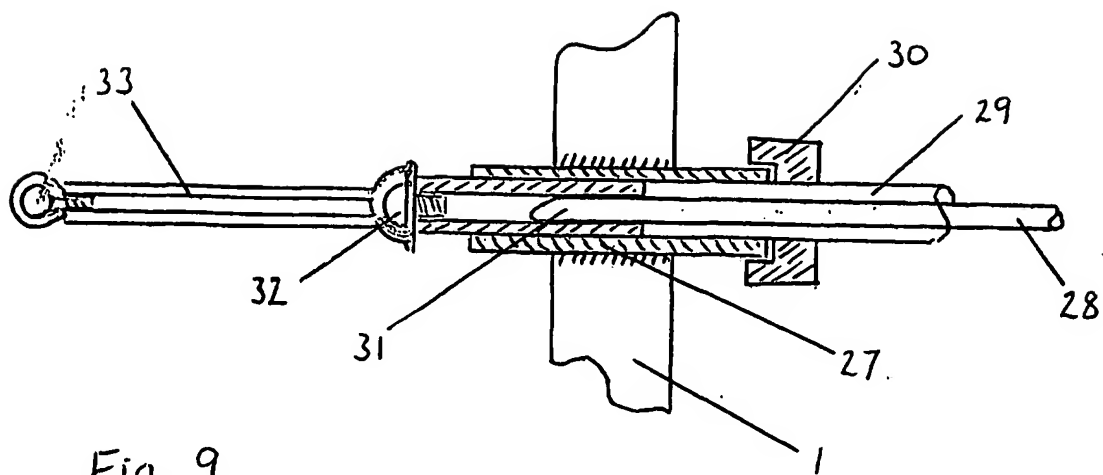
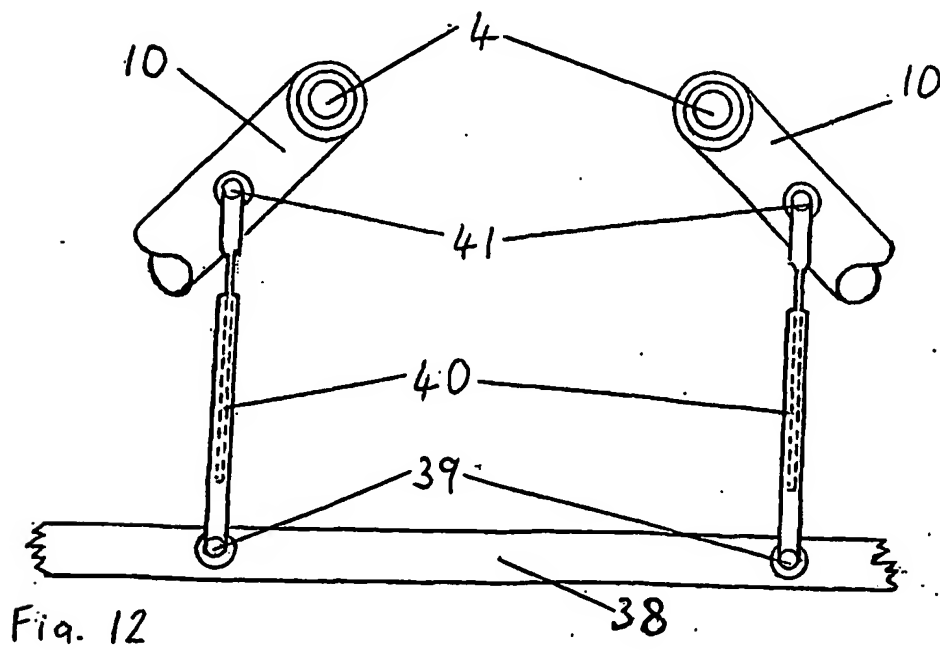
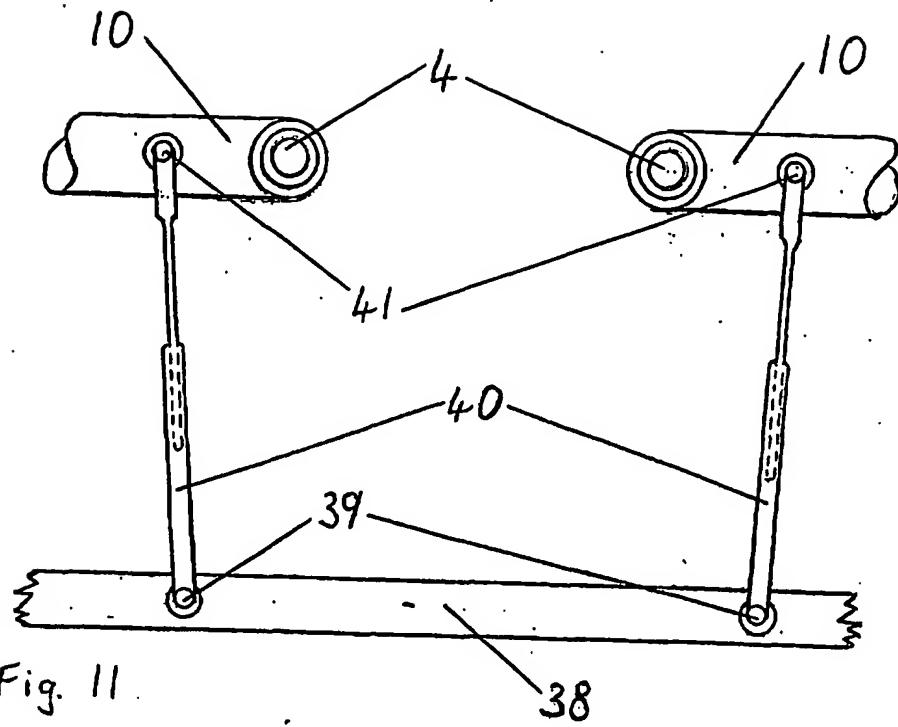


Fig. 6







A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60B35/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B60B B62D B61D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

A document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search

29 October 2001

Date of mailing of the international search report

06/11/2001

Name and mailing address of the ISA

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Verkerk, E

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